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A STUDY OF PIÑON PINE

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GENERAL DISTRIBUTION

No other tree species of the southern portion of the Rocky Mountain region presents more difficult problems in maintaining and reproducing the natural stands than does the piñon pine (*Pinus edulis*). It ranges from northern Mexico to eastern Utah, and Colorado Springs, Colorado. In an east-and-west direction it extends from the hills of western Texas to California. Along the northern and eastern borders of its range it is shrublike and of botanical importance only. In southern Colorado, Arizona, and New Mexico, it has a great economic and silvicultural importance, which will steadily decrease unless measures are taken to prevent excessive utilization.

It is commonly found in mixture with the one-seeded juniper (*Juniperus monosperma*) in the northern part of its range and with the alligator juniper (*Juniperus pachyphloea*) and one-seeded juniper in the south. Throughout its distribution it is associated with western yellow pine (*Pinus ponderosa*) and the scrub oaks (*Quercus Gambelii* and *Quercus acuminata*), often forming with these species a transition belt between stands of juniper and western yellow pine. Occasionally it is found with stunted Douglas fir (*Pseudotsuga taxifolia*). In association with the junipers, it forms the distinct woodland type so characteristic of New Mexico and Arizona, which in this region covers a more extensive area than any other forest type, and in which the piñon is decidedly the most important tree. It is occasionally seen in pure stands over small areas, but this is rare.

LOCAL OCCURRENCE

The tree thrives best at a general elevation of 1650 to 2350^m (5400 to 7700 feet) on moderate to steep mountain slopes and over broad, level, or sloping mesas. Small isolated specimens were found up to an elevation of 2600 and 2750^m (8500 and 9000 feet), while occa-

Botanical Gazette, vol. 48]

sional specimens may be found even higher than this. The best stands are found on coarse gravel, gravelly loam, or a coarse sand, of 1.5^m (5 feet) or more in depth, on which humus and ground cover are almost entirely lacking. The species often occurs on rocky areas, where the soil is only 15 to 30^{cm} (6-12ⁱⁿ) in depth, and frequently it is found growing in rock crevices. It is one of the first trees to gain a foothold on the lava overflows which are known throughout the southwest as *mal pais*. This rock in its disintegrated form supports fair tree growth, but even before disintegration has progressed very far, the junipers and piñon may be found encroaching upon it.

Another encroachment form of the piñon is to be found on small mounds which rise 0.6 to 3^m (2 to 10 feet) above the general level of the desert-like tableland at approximately 1500^m (5000 feet) elevation. On such islands as these, the piñon and one-seeded juniper take possession and maintain a limited growth. The same feature is noted at the bases of the hill and mountain slopes which bound these tablelands. This remarkably distinct tension line seems to be due to a greater soil porosity, less grass growth, and a smaller alkali content, which are manifest in slightly higher elevations. The distribution of these trees on such small mounds and limited in such a distinctive manner presents an ecological problem for future investigation.

On slopes where site conditions are favorable for western yellow pine, the piñon usually occupies the south and west aspects. Where conditions become less favorable, it occupies the north and east slopes, while the south and west slopes are bare or nearly so. This ability to stand poor conditions is also shown on a large number of mountain slopes ranging from 2830 to 3135^m (6000 to 7000 feet) in elevation, where scattering Douglas fir, of scrubby growth and badly affected with witch's broom, is found in the cañons; western yellow pine on the middle slopes; and piñon on the ridges and upper slopes, where the soil is scant and the soil moisture low.

A distinctive peculiarity was observed between Servilleta and Taos, New Mexico, in an open stand of the species in which approximately two-thirds of the trees have constricted bases at the surface of the ground. This constriction amounted to an average of 19^{mm} (0.75ⁱⁿ)

in radius, but was occasionally noted where it amounted to 38^{mm} (1.5ⁱⁿ). Such a constriction is often seen on individual trees in nearly any stand, but in no other case was it found to be a stand as characteristic as it was near Servilleta.

Piñon is also resistant to severe climatic conditions, since it will succeed over severely exposed slopes where the average annual precipitation is less than 33^{cm} (13ⁱⁿ) and where evaporation and transpiration are high because of the semi-arid climate, the large amount of sunshine, and the prevalence of winds. In this respect it is undoubtedly the most resistant pine in the southwest. However, it prefers a slightly greater precipitation and areas less exposed to the wind. An example of the unfavorable influence of strong winds and a close-textured soil was noted in the vicinity of Fort Stanton, New Mexico, where a level plateau of nearly 8^{km} (5 miles) in length did not support a single tree, while similar plateaus on all sides, with less wind sweep and a coarser soil, showed luxuriant growth of both the piñon and the juniper. The tree does not live as long as the junipers, and in general is less resistant to unfavorable climatic conditions. In the drought which occurred in New Mexico from 1889 to 1904, piñon suffered considerably more than the junipers. Many mixed stands were observed in New Mexico and southern Colorado in which 75 to 95 per cent. of all dead trees were piñon. In the frost which occurred in April, 1907, piñon was affected, while the junipers resisted practically all injury. In the wet freezing snow of October, 1906, which caused immense damage to the forests of the southwest, fewer branches were broken from the piñon than from the brittle junipers.

The tree is also more resistant to disease than most of the conifers with which it associates. It is much less affected by the so-called false mistletoe (*Razoumofskya*) than is the western yellow pine and the junipers. It has fewer insect enemies than the western yellow pine, and is not affected by the witch's broom as is often the case with Douglas fir in the southwest.

TOLERANCE AND FORM

Piñon is distinctly an intolerant tree. During its seedling stage it prefers a moderate shade, and hence reproduces best under the

shade of older trees. After the seedling stage is passed it prefers the open, and is one of the most intolerant of forest trees. This gives an orchard-like appearance to most stands of this species. Occasionally stands of 0.7 density were noted, although few stands have more than 0.6 density.

On the best sites the trees reach a maximum height of 12 to 13.7^m (40 to 45 feet) and a diameter of 60 to 75^{cm} (2 to 2.5 feet) at breast height, but ordinarily the mature individuals range from 3 to 10.5^m (10 to 35 feet) in height and from 15 to 45^{cm} (0.5 to 1.5 feet) in diameter. A difference in development was apparent on different sites. On exposed sites the tree is globular, very scraggly when mature, and has little or no clear length. On favorable sites trees in the open have a very short clear length and a fairly regular globular or egg-shaped crown. If grown in stands, the trees have a greater clear length and a flat or vase-shaped crown. Young trees on favorable sites are conical or globular in shape and usually very regular in form.

On the most exposed sites, shrublike trees were found which were fifty to eighty years old, and only 1.8 to 3^m (6 to 10 feet) in height, with a crown diameter reaching a maximum of two to four times the height of the tree. On such trees it was impossible to distinguish the leader from the branches, and the general appearance of the tree was much like that of the dwarf mountain pine (*Pinus monticola*). The foliage is more densely clustered on these dwarf trees than it is on trees in the open, with shorter and apparently thicker leaves. Practically all trees, whether growing on poor or good sites, are characterized by dead and half-dead branches, which are retained on the tree for several years. This is characteristic of nearly all species in the southwest and is due to the small amount of growth that is made, the necessity of retaining only a small amount of living tissue, and the dry nature of the climate, which allows the retention of dead branches for a longer period than would a moist climate. In exceptional stands, such as occur to the west of Servilleta, New Mexico, where a clear length of 4.5 to 7.6^m (15 to 25 feet) is not exceptional, the branches are shed largely because the density of stand prevents the formation of as large branches as are found in those trees which enjoy full sunlight.

WOOD

Piñon wood is moderately heavy for the pines. It is used extensively for fuel and has been limitedly used for fence posts, telephone poles, corral posts, mine lagging, railroad ties, charcoal, and inferior lumber. Some authorities have recommended its use for fence posts, but this is to be seriously questioned as it has little durability in contact with the soil, and even the natives are discarding it for such use. It may be rendered valuable, however, by the use of preservatives. The tree is remarkable in its fuel value, and its use for such a purpose should be greatly encouraged. It is a common practice to cut branches or trees after they have been dead about two years. If cut before this time, the wood has not seasoned sufficiently to burn readily. If cut after this time, it has usually deteriorated to some extent. As a hearth fuel, it is not surpassed by another conifer and by only few hardwoods. It starts to burn readily, retains fire for a considerable length of time, gives a large amount of heat, and does not throw sparks. Since open fires are very common in this region, this wood serves an excellent purpose. Sample acres which have been clear cut have given a yield of 180 to 360^{cu m} per hectare (20 to 40 cords per acre), while extensive stands have averaged 90 to 108^{cu m} (10 to 12 cords).

FRUIT

The young cones are dark red and occur in elongated clusters. The pistillate form is easily distinguished by short stalks. Both sorts are very plentiful in seed years, but are scarce during other years. The mature cone is short, top-shaped, 19 to 50^{mm} (0.75 to 2ⁱⁿ) long and often as broad as long. The cones open on the tree and are covered by a large amount of free resin, which makes them difficult to handle. They often occur on trees only 0.9 to 1.2^{mm} (3 to 4 feet) in height, which are ten to twenty years old, but the best crops are borne on mature trees which produce 35 to 280^l (1 to 8 bushels) of cones; each cone contains two to thirty seeds, with an average of ten to twenty seeds. The trees have been known to yield 336^{kg} of seed per hectare (300 pounds per acre), while a much larger area has been known to produce an average of 73^{kg} per hectare (65 pounds per acre).

Seed years usually occur at five-year intervals, but have been reported at shorter intervals than this. The seed is well rounded at the base, tapering with prominent ridges to an acute point. It is usually dark brown on the lower side, with more or less mottled orange yellow on the upper side, 9 to 12.5^{mm} (0.375 to 0.5ⁱⁿ) long, 6.5 to 9^{mm} (0.25 to 0.375ⁱⁿ) broad, with a thin shell which cracks most easily along the line of the most prominent ridge. The seed wings are about one-half the length of the seed, easily detached, and of no practical use in seed distribution. The seeds usually have a high percentage of infertility, which varies from 5 to 20 per cent., but in one case went as high as 85 per cent. Poor seeds are often lighter in color than good seeds. Germination power is lost very readily, which necessitates special storing when they are to be used for artificial planting, and good site-conditions when the stands are to be reproduced naturally. It is a matter of note that the seeds from the northern portion of the range are usually considered better than those from the south. Five samples collected in various localities gave the following results:

No. per pound (453.6 g ^m)	Percentage viable; knife test	Percentage viable; water test	Percentage viable; in greenhouse	Percentage viable; in open	Where collected
2510	87.2	84.0	82.2	75.6	Ft. Bayard, N. M.
2215	89.1	86.6	80.3	69.2	Tres Piedras, N. M.
1810	91.2	86.0	78.1	70.4	Ft. Garland, Col.
1950	92.7	88.5	81.3	71.0	Ft. Garland, Col.
1520	99.2	97.1	96.4	90.3	Lincoln, N. M.

Weevils sometimes affect the seed before the cones open. Birds and rodents eat the seed extensively, and stores are made by mountain rats which were found to contain a maximum of 35 to 70^l (1 to 2 bushels) of clean seed. Ants are known to eat seed, especially at lower levels. In the early days, the Indians and Mexicans used the piñon as a staple article of food. At present, it is gathered in immense quantities and sold as a delicacy. It is eaten most extensively in and about the region where the tree grows naturally, but large amounts are being sold at fruit stands throughout most of the United States. To prevent the seeds from spoiling and to retain flavor, they are usually baked immediately after being gathered.

Most of the seeds are collected by Mexican women and children, who usually spread a sheet or blanket on the ground and then shake or pound the tree and its branches until the seeds fall from the open cone. Later in the season, the seeds are picked up by hand from the ground beneath the trees. In the best part of the seed harvest, enough are gathered by single families to be sold by the grain bag full or the wagon load. Since the Mexicans take almost no precautions against the spreading of smallpox, it is said that the worst ravages of the disease occur during a seed year of the piñon. Single dealers have been reported as having bought 9000 to 21,500^{kg} (20,000 to 50,000 pounds). The delicate flavor of the seed makes it a favorite, and an extensive market is being rapidly developed for it. During seed years the native collectors sell it at the rate of five to fifteen cents per pound, according to the ease of collecting the seed and the proximity of the market, while dealers in many of our cities sell the seed at a rate of forty to sixty cents per pound.

REPRODUCTION

Natural reproduction is limited because of the infrequency of seed years, unfavorable climatic conditions, infertility of seed, rapidity with which the seed loses its germination power, loss of seed eaten by rodents, birds, and man, and unfavorable site-conditions. Grazing interests are also a factor in limiting the reproduction of the species, since sheep, cattle, and goats are grazed throughout its entire distribution. It is apparent to even the casual observer that extremely large areas are not reproducing themselves, yet owing to the difficulties of site and the methods by which the tree may be reproduced, the problem of reproduction is an extremely difficult one, and one for which, at the present time, no adequate solution can be offered.

FUTURE MANAGEMENT

From the nature of the stand in the southwest, it is apparent that clear cutting would not be an advisable system, because of the exposure of the site and the difficulties of restoring the stand. On the other hand, the large amount of seed consumed by man and other agencies makes natural seeding exceedingly difficult, and even though grazing and fire are entirely eliminated, it is doubtful if satisfactory reproduc-

tion will be secured in even a bare majority of sites. Until the problem of reproduction is more thoroughly worked out, the policy should be to remove only the dead and dying piñon trees for fuel, thus allowing a careful management without encroaching seriously upon the natural stands as is being done at the present time. It would seem from the nature of the site that the stand could be made to succeed best by the selection system, consisting of the removal of the dying trees. The sale of this fuel with that of a large portion of the seed should furnish a moderate income. This production would be low, as contrasted with high-type coniferous forests in other regions, but when consideration is given to the value of this species for fuel and seed, the question of immediate returns is a minor one.

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